MICROMECHANICS-BASED ELASTIC MODEL FOR FUNCTIONALLY GRADED COMPOSITES WITH PARTICLE INTERACTIONS

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Mechanical properties are crucial for functionally graded composites applied as structural materials. The present paper aims to develop a micromechanics-based effective elastic model of functionally graded composites. Microstructurally, particles are randomly dispersed in the matrix with gradual transitions. They are assumed to be spherical, nonintersecting, and perfectly bonded with the matrix. At the macroscopic scale, the overall material properties of the composites are uniform in the same graded layer while changing gradually along the grading direction. The effect of pair-wise interactions between particles is taken into account for the local stress and strain fields by using the modified Green's function method. At each material layer, particles are uniformly distributed. However, particle concentration gradually increases in the grading direction. Through integrating the interactions from all particles in the layer and grading direction separately, the homogenized elastic strains and stresses are estimated as functions of constituents' properties and the length scale of material gradation. The effective elastic modulus tensor of the functionally graded composites is further constructed. The model prediction is compared with available experimental data.